APPLICATION UNDER UNITED STATES PATENT LAWS

Atty. Dkt. No. 071469-0306776

Invention: METHOD AND APPARATUS FOR THERMALLY INSULATING ADJACENT TEMPERATURE CONTROLLED PROCESSING CHAMBERS

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This is a:

☐ Provisional Application

☒ Regular Utility Application

☐ Continuing Application
☐ The contents of the parent are incorporated by reference

☐ PCT National Phase Application

☐ Design Application

☐ Reissue Application

☐ Plant Application

☐ Substitute Specification
Sub. Spec Filed ____________
in App. No. ______/______

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Sub. Spec. filed ____________
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SPECIFICATION

METHOD AND APPARATUS FOR THERMALLY INSULATING ADJACENT TEMPERATURE CONTROLLED PROCESSING CHAMBERS

[0001] This non-provisional application claims the benefit of U.S. Provisional Application No. 60/454,644, which was filed on March 17, 2003, the content of which is hereby incorporated in its entirety.

CROSS-REFERENCE TO RELATED APPLICATIONS

[0002] This application is related to co-pending United States patent application serial no. 10/XXX,XXX, entitled "Processing System and Method for Chemically Treating a Substrate", Attorney docket no. 071469/0306773, filed on even date herewith; co-pending United States patent application serial no. 10/XXX,XXX, entitled "Processing System and Method for Thermally Treating a Substrate", Attorney docket no. 071469/0306775, filed on even date herewith; and co-pending United States patent application serial no. 10/XXX,XXX, entitled "Processing System and Method for Treating a Substrate", Attorney docket no. 071469/0306772, filed on even date herewith. The entire contents of all of those applications are herein incorporated by reference in their entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0003] The present invention relates to a method and apparatus for thermally insulating adjacent temperature controlled processing chambers.

2. Description of Related Art

[0004] Processing chambers, such as those used in semiconductor manufacturing, often need to be maintained at a particular temperature to be operative. Examples of temperature sensitive processes include chemical oxide removal (COR) treatment and substrate heat treatment.

[0005] COR treatment can be used to process a mask in an oxide layer of a semiconductor device which can be used to etch a substrate with feature dimensions around 100 nanometers or less. COR treatment may include exposing surfaces of the oxide layer to process gases and heat treating the chemically treated oxide of the semiconductor device.

[0006] It may be desirable to perform each of these processes (i.e., chemical treatment and heat treatment) at different temperatures. Accordingly, these processes may be performed in different chambers. Additionally, exposure of the semiconductor device outside of the chambers may not be desirable between the processing phases.

SUMMARY OF THE INVENTION

[0007] The present invention provides a novel method and apparatus for thermally insulating adjacent temperature controlled processing chambers, or adjacent processing chambers of different temperature.

[0008] A dual chamber apparatus is provided with a first chamber and a second chamber which is configured to be coupled to the first chamber at an interface. Each of the first chamber and the second chamber has a transfer opening located at the interface. An insulating plate is located on one of the first chamber and the second chamber at the interface and is configured to have a low thermal conductivity such that the first chamber and the second chamber can be independently controlled at different temperatures when the first chamber and the second chamber are coupled together. Additionally, the apparatus may include an alignment device and/or a fastening device for fastening the first chamber to the second chamber. In embodiments, the insulating plate may be constructed of Teflon. Further, the first chamber may be a chemical oxide removal treatment chamber and the second chamber may be a heat treatment chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The accompanying drawings, which are incorporated in and constitute a part of the specification, of embodiments of the invention, together with the general description given above and the detailed description of the embodiments given below, serve to explain the principles of the invention wherein:

[0010] FIG. 1 is a perspective view of a first processing chamber which can be thermally insulated from a second processing chamber in accordance with an embodiment of the present invention;

[0011] FIG. 2 is a side view of the first processing chamber shown in FIG. 1 in accordance with the principles of the present invention;

[0012] FIG. 3 is a top view of the first processing chamber shown in FIGs. 1 and 2 in accordance with the principles of the present invention;

[0013] FIG. 4 is a cross-sectional side view of the first processing chamber shown in FIGs. 1, 2, and 3 in accordance with the principles of the present invention;

[0014] FIG. 5 is a perspective view of the second processing chamber which can be thermally insulated from the first processing chamber in accordance with an embodiment of the present invention;

[0015] FIG. 6 is a cross-sectional side view of the second processing chamber shown in FIG. 5 in accordance with the principles of the present invention;

[0016] FIG. 7 is a cross-sectional side view of the first and second processing chambers in accordance with the principles of the present invention; and

[0017] FIG. 8 is another cross-sectional side view of the first and second processing chambers in accordance with the principles of the present invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

[0018] The present invention will be described below with reference to the illustrative embodiments disclosed.

[0019] FIG. 1 is a perspective view of a first processing chamber 10 which can be thermally insulated from a second processing chamber in accordance with an embodiment of the present invention. FIG. 2 is a side view of the first processing chamber 10 shown in FIG. 1 in accordance with the principles of the present invention and FIG. 3 is a top view of the first processing chamber 10 shown in FIGs. 1 and 2 in accordance with the principles of the present invention. FIG. 4 is a cross-sectional side view of the first processing chamber shown in FIGs. 1, 2, and 3 in accordance with the principles of the present invention. As shown, processing chamber 10 includes a substrate transfer opening 12 for transferring a substrate from the first chamber 10 to a second chamber. Additionally, an interface plate 14 may be provided and may include at least one contact member 16 for making contact with the second chamber. The contact member maintains firm structural contact between the first chamber 10 and the second chamber and may have a much smaller surface area than the insulator plate such that the contact between the first chamber and the second chamber is minimized. A mating device 18 which includes an insulator plate 20 is provided around the transfer opening 12. The insulating plate 20 has a sufficiently low conductivity so as to minimize the thermal contact between the first chamber 10 and the second chamber. In embodiments, the insulating plate 20 may be

constructed of Teflon™. Other materials can include polyimide, ceramic materials, and thermally insulating materials such as alumina, quartz, etc.

[0020] Chamber fastening devices 22 may be provided to securely fasten the first chamber 10 to the second chamber. As shown in FIG. 3, fastening devices 22 are fastened to the first chamber 10 from a flange formed within the chamber. Although the chamber fastening devices are shown as pins or screws, it should be understood that other fastening devices may also be used. For example, the chambers can be bound together from the outside using, for example, claw clamps or other clamping devices. In addition to the fastening devices 22, alignment devices 24 may be provided so the first chamber 10 can be more easily aligned with the second chamber. In FIG. 1, the alignment devices 24 are pins which will quickly align with holes in the second chamber to ensure that the two chambers are aligned properly. Although shown as pins, one of ordinary skill in the art would easily understand that other methods for alignment may be used as well. For example, a key-like structure could be constructed to allow the second chamber to sit within the first chamber 10.

[0021] As shown in FIG. 4, a plurality of seals 28 provide essentially air-tight seals between the various components. The air-tight seals can facilitate different pressures (vacuum, atmospheric, above atmospheric pressure) in each chamber. The air-tight seals can, for example, comprise an elastomer material (e.g., fluorosilicone, nitrile, fluorocarbon, silicone, neoprene, ethylene propylene, etc.). These materials are generally selected per application based upon the following physical characteristics: resistance to fluid, hardness, toughness, tensile strength, elongation, o-ring compression force, modulus, tear resistance, abrasion resistance, volume change, compression set, thermal effects, resilience, deterioration, corrosion, permeability, coefficient of friction, coefficient of thermal expansion, outgas rates, etc. Additionally, gate adapter plate 30 may also be provided around the transfer opening 12. The gate valve assembly 26 moves vertically to seal the transfer opening 12 during processing, cleaning, or whenever the first and second chambers may need to be isolated from each other.

[0022] In embodiments, the first chamber 10 may be a chemical oxide removal treatment chamber and accordingly, may include a gate valve assembly 26, as shown in FIG. 1. Additionally, the inside of the chambers may be essentially evacuated as would be the case for the first chamber 10 if it were a chemical oxide removal treatment chamber. Further, in the described embodiment of FIGS. 1-6, the insulating plate 20 would help

maintain an essentially air-tight seal between the chambers. During processing, the environments within chambers 10 and 50 are generally maintained at reduced pressure. Therefore, in order to maintain a reduced pressure atmosphere (vacuum) relative to the external environment (i.e. atmospheric pressure outside of the chambers), the design and assembly of the chambers, and their interconnection should be such that vacuum integrity is maintained. In the described embodiment, the insulating plate 20 serves to thermally insulate the two chambers at their interconnection, and provide sealing surfaces at their interconnection.

[0023] FIG. 5 is a perspective view of the second processing chamber 50 which can be thermally insulated from the first processing chamber 10 in accordance with an embodiment of the present invention. FIG. 6 is a cross-sectional side view of the second processing chamber 50 shown in FIG. 5 in accordance with the principles of the present invention. The second chamber 50 includes alignment holes 54 which correspond to the alignment device 24 shown on the first chamber 10. Accordingly, the alignment device 24 fits within the alignment holes 54. Additionally, fastening holes 56 are provided and configured to accept the fastening device 22 shown on the first chamber 10. FIG. 7 illustrates the coupling between the first chamber 10 and the second chamber 50. Around substrate transfer opening 52 is a seal groove 60 which is configured to accept a seal 28A, and, when pressed against a first surface 20A of the insulator plate 20, provides a vacuum seal between the second chamber 50 and the first surface 20A of the insulating plate 20. Additionally, around the transfer opening 12 is a seal groove 29 which is configured to accept another seal 28B, and, when pressed against a second surface 20B of the insulating plate 20, provides a vacuum seal between the interface plate 14 coupled to the first chamber 10 and the insulating plate 20. The design is such that vacuum integrity and structural integrity are maintained, and the two chambers 10 and 50 are thermally insulated from one another, as described above. Additionally, an attachment flange 58 may be provided to more securely fasten the first chamber 10 to the second chamber 50 (see FIG. 5).

[0024] In an alternate embodiment, FIG. 8 illustrates another coupling between the first chamber 10 and the second chamber 50, wherein the design is such that vacuum integrity and structural integrity are maintained, and the two chambers 10 and 50 are thermally insulated from one another. The coupling comprises an interface plate 114 having a flange portion 114A, a frontal portion 114B, and an insulating plate 120. The

frontal portion 114B extends through the insulating plate 120 to mate with the gate valve 26. Around the flange portion 114A of the interface plate 114 is a seal groove 160 which is configured to accept a seal 128A and which provides a vacuum seal between the interface plate 114 and the insulating plate 120 when pressed against a first surface 120A of the insulator plate 120. Around the substrate opening 12 is a seal groove 129 which is configured to accept a seal 128B and which provides a vacuum seal between the insulating plate 120 and the first chamber 10 when pressed against a second surface 120B of the insulator plate 120. Additionally, around the substrate transfer opening 52 is another seal groove 130 which is configured to accept a seal 128C and which provides a vacuum seal between the second chamber 50 and the interface plate 114 when pressed against the second chamber 52. Additionally, around the substrate transfer opening 12 is a seal groove 131 configured to accept a seal 128D which provides a vacuum seal between the interface plate 114 and the gate valve 26 when pressed against the interface plate 114. Interface plate 114 further comprises at least one contact member 116 for making contact between the first chamber 10 and the second chamber 50. The contact member maintains firm structural contact between the first chamber 10 and the second chamber 50 and may have a much smaller surface area than the insulator plate 120 such that the contact between the first chamber 10 and the second chamber 50 is minimized. In the embodiment described in FIG. 8, a continuous heat path is formed between the second chamber 50, the interface plate 114, and the gate valve 26. However, the second chamber 50 is thermally insulated from the first chamber 10 via the insulating plate 120. Conversely, in the embodiment described in FIG. 7, a broken heat path is formed between the second chamber 50, and the interface plate 114 and the gate valve 26. However, the second chamber 50 is still thermally insulated from the first chamber 10 via the insulating plate 120.

[0025] In embodiments, the second chamber 50 may be a heat treatment chamber.

[0026] The foregoing presentation of the described embodiments is provided to enable any person skilled in the art to utilize the present invention. Various modifications to these embodiments are possible and the generic principle of thermally insulating adjacent temperature controlled processing chambers presented herein may be applied to other embodiments as well. For example, the structures described by way of FIGs. 1-4 may be located on the second chamber 50 and the devices described with regard to FIGs. 5 and 6 may be located on the first chamber 10. In fact, any combination of locations would

be acceptable. For example the fastening devices 22 may be on the first chamber while the alignment devices 24 are located on the second chamber. The insulating plate and mating device can also be located on either of the chambers, as can the gate valve assembly. Thus, the present invention is not intended to be limited to the embodiments shown above, but rather to be accorded the widest scope consistent with the principles and novelty of the features disclosed in any fashion herein.